SEM STUDIES OF ANTARCTIC LUNAR AND SNC METEORITES WITH IMPLICATIONS FOR MARTIAN NANOFOSSILS: A PROGRESS REPORT. Anne Elizabeth Taunton, Cosmochemistry Group, Department of Chemistry and Biochemistry, University of Arkansas, Fayetteville, Arkansas 72701, USA.

Several meteorites recovered from Antarctica are believed to have a martian origin. This is evidenced by their ages, chemical compositions, morphologies and trapped gases [1-3]. McKay *et al*. recently reported finding evidence of possible past life in one of the martian meteorites citing mineralogy, morphological phases, PAHs, and microfossils [4]. However, alternate explanations of the origin of the microfossils include them being laboratory artifacts or Antarctic contamination, since bacteria are known to survive in very harsh conditions including Antarctica. The purpose of this project is to examine these alternate explanations by studying several Antarctic lunar and SNC meteorites. If forms are found in lunar meteorites that are similar or identical to those found in martian meteorites, then it will be hard to rule out the idea that the forms are artifacts or contamination.

The moon is an extremely harsh environment, incapable of supporting life. The surface temperature increases approximately 260K from just before lunar dawn to lunar noon. The subsurface temperatures vary greatly from that, being about 45K higher. The moon's atmosphere is about 14 orders of magnitude less than the Earth's. Because of this, the moon is bombarded with radiation: solar wind, galactic cosmic rays, and solar cosmic rays [5]. Notwithstanding a recent announcement of possible ice deposits near the pole [6], the lunar surface is exceptionally dry. Thus, no type of life forms should be present in lunar meteorites.

Eight chips of lunar meteorites and three chips of martian meteorites are being studied (table 1):

Table 1 Samples studied

Meteorite	Description [7][8]
ALH 81005*	Anorthositic regolith breccia-Highland
EET 87521	Basaltic breccia-Mare
MAC 88104**	Anorthositic regolith breccia-Highland
MAC 88105**	Anorthositic regolith breccia-Highland
QUE 93069*	Anorthositic breccia
QUE 94281	Basalt-rich breccia
EET 79001	Basaltic shergottite
ALH 77005	Lherzolitic shergottite
ALH 84001	Coarse-grained orthopyroxenite

*two chips were studied
**paired meteorites

All samples, with the exception of ALH 81005, were freshly fractured. All were mounted on either a graphite disk or planchette using double sided tape and/or carbon paint. The samples were gold-palladium sputter coated for 30-60 seconds at 10-12 mA and 2400 volts to make them conductive for SEM study. Each sample was studied under a Philips 40XFEG scanning electron microscope. A chemical analysis of several regions in QUE 93069 was performed using energy dispersive x-ray analysis.

McKay *et al.* used criteria established by Folk [9]:

1. Clusters of bodies separated by large, unpopulated areas
2. Bodies same size as normal bacteria. Bacteria can become stressed under changing conditions and may "shrink" to nanobacteria size. However, nanobacteria have been observed in non-stressful environments, suggesting that they have no "large" size equivalent.

3. Populations same as normal bacteria. They can be well-sorted, bi-modal or a mixture of different types of bacteria at various stages of sporulation and/or nutrition.
4. Bodies similar in shape and texture of normal bacteria: smooth to somewhat lumpy surfaces with the shapes of cocci, bacilli, ellipses, or long filaments. They can appear as chains of spheres or rods.
5. Bodies do not contain iron, but may have Ca or Si which are precipitates of bacteria.
6. Bodies must be distinct from minerals or artifacts. They must be observed at very high magnifications (at least 35000X) to verify that the shapes are sphere ellipsoids or rods rather than cubes.

McKay *et al.* added iron-bearing magnetotactic bacteria, bacteria that contain magnetite. Using the McKay *et al*. characteristics, an attempt to locate forms in the lunar and martian meteorites that could be possible microfossils is being made.

Approximately 235 microbiologists and SEM specialists were solicited to take part in a blind test. Out of 56 responses, 35 were positive. If attempts to locate forms in both lunar and martian meteorites are successful, then these 35 participants will be sent a plate with six unlabeled micrographs of forms in lunar meteorites mixed with six unlabeled micrographs of forms in SNC meteorites. The specialists will be asked to sort the micrographs into categories if they can, keeping in mind the characteristics used by McKay *et al*. They will also be asked to make any comments they wish on population distribution, size, and recognizabilty. A statistical analysis will be performed, and the results will be given at a later date.

With the blind test we are providing objective results to a subjective question. The microbiologists and SEM specialists were selected randomly for solicitation by collecting names and addresses of contributors in the *Journal of Microbiology, Scanning Electron Microscopy* and several books on microbiology and scanning electron microscopy. A letter was sent including a return postcard indicating interest. Thus, the participants were self-selected based on their expertise in the area of SEM imaging of bacteria.

The purpose of this project is not to identify the forms found in the meteorites; it is simply to compare the forms. Regardless of what they actually are, the vital piece of information is whether or not the forms are found in both the lunar and the martian samples. If they are in both meteorites or if they are found only in lunar samples, then a martian origin can be excluded, and we have identified Antarctic contaminants, inorganic material and/or laboratory artifacts. If found only in martian samples, then we have strengthened the case for martian microbes.

The lunar samples have presently been studied and imaged, and the SNC meteorites will be studied throughout February and March. If the project is successful, the plate of micrographs will be sent out during the first two weeks of April and statistical analysis will be completed in May.

[1]Bogard D. D. and Johnson P. (1983) *Science* **221** 651-655, [2]Miura Y.N. *et al.* (1994) *Lunar Planet. Sci. XXV* 919-920, [3]Miura Y.N. *et al*. (1995) *Geochim. Cosmochim. Acta* **59** 2105-2113, [4]McKay D. *et al.* (1996) *Science* **273** 924-928, [5]Vaniman D. *et al.* “The Lunar Environment” in *Lunar Source Book: A User s Guide to the Moon* (1991) 27-69, [6]Nozette, S. *et al.* (1996) *Science* **274** 1495-1498 [7]Benoit, P. (1996) *Meteorit. and Planet. Sci.* in press. [8]McSween, H.Y. (1994) *Meteoritics* **29** 757-779, [9]Folk, R. (1993) *Jour. Sed. Pet.* **63** 990-993.